NASA Planetary Data: Applying Planetary Satellite Remote Sensing Data in the Classroom. Patricia Liggett[1], Elaine Dobinson[1], Douglas Hughes[1], Michael Martin[1], Debbie Martin[1], Betty Sword[1] [1]JPL 4800 Oak Grove Dr. Pasadena Ca 91101, California Institute of Technology, 1200 California Boulevard, Pasadena, California 91125

ABSTRACT

Introduction: NASA supports several data archiving and distribution mechanisms that provide a means whereby scientists can participate in education and outreach through the use of technology for data and information dissemination. The Planetary Data System (PDS) is sponsored by NASA's Office of Space Science [1]. Its purpose is to ensure the long-term usability of NASA data and to stimulate advanced research.

In addition, the NASA Regional Planetary Image Facility (RPIF), an international system of planetary image libraries, maintains photographic and digital data as well as mission documentation and cartographic data [2]. There are ten US and 8 international RPIFs, each facility is a reference center for browsing, studying and selecting photographic and cartographic materials from its general holding of images and maps of planets and their satellites taken by solar system exploration spacecraft. Each RPIF is staffed to assist scientists, educators, students, media, and the public in ordering materials for their own use

Both the PDS and the RPIF, while chartered primarily to support the scientific community, have been providing support to education and public outreach. Both provide access to and distribution of images and information about the planetary science resident in their sites. PDS provides web access to its archives of data and several tools that provide a non-science user to view images and learn more about them.

The Planetary Data System (PDS) consists of seven nodes each containing a specific portion of the planetary data sets. The Imaging Node at JPL contains images of the planets. The Atmospheric Node at New Mexico State University contains non-image atmospheric data. The Geosciences Node at Washington University in St. Louis Missouri contains data used in study of the surfaces and interiors of terrestrial planetary bodies. The Rings Node at the NASA Ames Research Center in San Jose contains data sets relevant to planetary ring systems. The Small Bodies Node (SBN) at the University of Maryland specializes in data concerning asteroids, comets and interplanetary dust. The Planetary Plasma Interactions Node at UCLA contains data related to the study of magnetospheres and interactions with the interplanetary plasma. While each is accessible from the World Wide Web, each is geared primarily for supporting scientific research.

A working group has been formed to look at possibilities for leveraging off the products and capabilities, both at the PDS and the RPIFs. Many of these products and capabilities were developed initially to support the science community, through leveraging NASA OSS can further utilize these existing programs, engage the science community in education, and provide the education community with additional support in teaching sciences in all classrooms.

Description: There are many challenges to getting the science data collected from the planetary missions into a form and format that can be used by educators in the K-12 classroom. The Planetary Data System (PDS) archives and distributes scientific data from NASA planetary missions, astronomical observations, and laboratory measurements and includes tools and technologies for accessing data by educators and the general public.[1] Likewise the RPIFs, which general holding contains images and maps of planets and their satellites taken by solar system exploration spacecraft provides mechanisms for accessing information[2]. Yet more is needed and more is being done to make science data not only available but also compatible with the lesson planning of the educator and usable within the learning environment of the classroom.

Applications: Both PDS and the RPIFs include images and related documentation available for educators in K-12. Packages such as Welcome to the Planets [3], which

contains a collection of many of the best images from NASA's planetary exploration program, can be accessed via link from PDS. The collection has been extracted from the interactive program "Welcome to the Planets" which was distributed on the Planetary Data System Educational CD-ROM Version 1.5 in December 1995. It has also been updated with the addition of more recent images and can be ordered online. Welcome to the Planets contains images of the planets and comets as well as of the spacecraft. In addition, annotation is provided with the images to better understand the image contents.

Tools such as DataSlate [4] are available for viewing, measuring, and interpreting data from the PDS and other NASA sources. DataSlate is part of the CASDE educational tools that facilitates intuitive, graphical search of large image map, and other visual data sets. It allows the quick comparison of data of different types covering the same region. DataSlate's power derives from a data structure that co-registers data of different types. As one moves about a particular dataset, all other datasets are kept in spatial synchronization. The user can click from a natural color image to an infrared image or to a radar image and examine the same region at these different points in the spectrum.
This tool can be acquired via the web at http:// casde.jpl.nasa.gov/dataslate/.

A tool developed at the USGS for PDS allows the user to access a PDS planetary image and select portions of the image for immediate display or download to a file that can be further manipulated in other image processing and analysis tools. It is located at a web site designed by the Planetary Data System's Imaging Node to provide a global point and click system for exploring various planets. The web page uses PDS images plus software known as MapMaker[5] to make its maps.

Each of the seven nodes that make up the Planetary Data System, provides access to local tools and information related to the data in the archive. However, more is needed to help the teacher to use the tools and technologies in the classroom through training of the teachers as well as well developed, intuitively designed, and well documented products that can be readily used by the students. In addition, all tools developed for the classroom need to meet the education standards and curriculum needs of the educator.

Benefits to teachers and students. The ability to access "live" data from a repository utilized by the global science community lends meaning to the involvement by the student. In addition, use of "live" space science data helps to inspire and encourage the student to engage in scientific thought and potentially to consider further science study. Applications such as these have been useful not only for teaching and understanding space science but also in teaching fundamentals such as reading and basic research techniques. It also helps to provide the student with a sense of place and purpose within the larger context of space and science. Finally, the use of technologies and capabilities such as these encourages the use of government provided information and resources which in turn helps to encourage the government agencies to provide more support to education applications.

Upcoming activities A working group was formed to address greater use of PDS, RPIFs and application technologies to support educators use of PDS and RPIFs. This group looked at the available tools and technologies for using planetary data in the classroom. A study was done of teachers needs and expectations for using these data and technology in the classroom. As well as determine how to apply planetary data and the presentation technology in education. In addition, the distribution and training for use of planetary data and application technology was examined to develop a strategy that increases and enhances the use of the PDS and the RPIFs in the education process. The working group looked at the lessons learned by the Earth Science education community to gain from what they have learned and experienced. A report is being generated for presentation by the Solar System Educators Forum to NASA OSS E/PO and follow-on activities are being passed along to new working groups being formed.

New capabilities on the horizon
The Dear Mars [6] project, which is currently under early-phase prototyping, will allow students to interact with a Mars's mission in

real-time using a natural language interface to send emails to robotic instruments on the surface of Mars. Other new technologies are in development that will allow easier access to the PDS from other products. The Planetary Product Server currently under development will allow image data to be accessed for many available image-processing tools. Use of tools and technologies originally developed for Earth data processing and analysis will be examined for possible interfacing to the Planetary Data System.

References:[1] Elaine Dobinson, Planetary Data Systems Homepage, April 12, 01 <*http:// pds.jpl.nasa.gov/.*> July 19, 01, [2] Debbie Martin, Regional Planetary Imaging Facility, June 21, 00, <http://www.lpi.usra.edu/library/RPIF/RPIF.html/> July 19, 2001, [3] Michael Martin, Welcome to the Planets, May, 01, <*http://pds.jpl.nasa.gov/ planets/welcome.htm*>, July 19, 01 [4] Michael Martin, DataSlate, <*http://casde.jpl.nasa.gov/dataslate/*> ,July 19, 01, [5] <http://pdsmaps.wr.usgs.gov/maps.html>. Eric M Eliason, eeliason@usgs.gov Douglas Hughes, Dear Mars, June, 01, <*http://dearmars.jpl.nasa.gov/*> July 19, 01

BIOGRAPHY

Patricia Liggett is a Program Manager at JPL in information system research and development programs and is supporting the Education office in developing ideas and applications for the Planetary Data System in education. She has a background in computer science and has spent most of her 17 years in development of mission operation and science data analysis systems.